



## Rediscovery of *Passiflora danielii* Killip, 1960 (subgenus *Passiflora*): a threatened narrow endemic species of Colombia

John Ocampo<sup>1\*</sup>, Jorge Julián Restrepo<sup>2</sup> and Wilmer Giraldo<sup>2</sup>

1 Universidad Nacional de Colombia sede Palmira/Centro Internacional de Agricultura Tropical – CIAT/DAPA. Facultad de Ciencias Agropecuarias, Cra. 32 Chapinero, vía a Candelaria, Palmira, Valle del Cauca, Colombia

2 Universidad Nacional de Colombia sede Medellín. Facultad de Minas, Calle 59A No 63 – 20, Núcleo El Volador, Medellín, Antioquia, Colombia

\* Corresponding author. E-mail: jaocampop@unal.edu.co

**Abstract:** *Passiflora danielii*, an endemic species to Colombia, which is threatened, was rediscovered in the Department of Antioquia, where it has not been reported since 1938. The species was only known from the type locality (Municipality of Cocorná). Now, four new locations are added near it. The current study further presents a revised morphological description of *P. danielii* based on fresh material, along with an updated distribution map. Finally, following the IUCN Red List Criteria, *P. danielii* was classified as Critically Endangered (CR) species.

**Key words:** tropical Andes, biodiversity, Antioquia, Passifloraceae, Critically Endangered

The Passifloraceae comprise 17 genera and approximately 650 species, distributed throughout the tropics from the coastal zones up to 4,200 m in the Andes (Ulmer and MacDougal 2004). *Passiflora*, with about 576 species, is numerically and economically the most important genus of the family with alimentary, ornamental and pharmaceutical interest (Yockteng et al. 2012). In the most extensive monograph of the genus, *Passiflora The American Species of Passifloraceae*, Killip (1938) classified 355 species into 22 subgenera, based on floral morphology. More recently, Feuillet and MacDougal (2003) proposed a new infrageneric classification, recognizing only four subgenera: *Astrophea* (D.C.) Mast., *Decaloba* (D.C.) Rchb, *Deidamioides* (Harms) Killip and *Passiflora*, and downgrading most of Killip's divisions to lower levels. Krosnick et al. (2009) recognized subgenus *Tetrapathea* (DC.) Green from Oceania, raising the number of subgenera to five.

Passionflowers are generally perennial lianas or herbaceous vines climbing by tendrils, although some are trees, shrubs, or even annuals. Additional, typical

vegetative traits include alternate leaves, axillary stipules, and petiolar and/or laminar nectary glands. The subgenus *Passiflora* includes ca. 252 species and exhibits several unique floral features, such as an androgynophore, a complex corona constituted of one or several concentric rows of filaments, and a limen-operculum system limiting access to the nectary chamber, with impressive interspecific variation in size, shape and colors (Killip 1938). Their wide morphological variation appears to result from the diversity of their habitats as well as their coevolutionary relationships with many organisms, including protective ants, herbivores such as *Heliconius* spp. (Lepidoptera: Nymphalidae), pollinators, and the plant communities providing them physical support and access to sunlight (Yockteng et al. 2012).

Colombia is divided into 32 "departments", administrative units equivalent to provinces or states, and six main biogeographic regions: Amazonian, Andean, Caribbean, Orinoquian, Pacific and Insular. The Andean region presents a highly varied topography (100–5,400 m above sea level) with three main mountain ranges. The uplift of the Andes created new habitats and increased local isolation, favoring high speciation rates in many taxa (Gentry 1986). As a result of this habitat diversification, the Colombian flora comprises one of the world's most diverse groups of vascular plants, with 51,220 documented species (Myers et al. 2000; Kreft and Jetz 2007). However, Colombia has undergone recent transformation of large portions of its natural ecosystems, in particular in the Andean region due to development of agriculture and extensive livestock production, mining, hydroelectric generation, and illicit crops. Destruction of natural habitats has drastically affected many species distributions, often reducing their historical ranges to a set of small, fragmented populations (Brooks et al. 2002). Such habitat alteration is predicted to lead to substantial extinctions in the near future.

In Colombia, Passifloraceae are represented by 171 species grouped in three genera, *Ancistrothrysus* (2), *Dilkea* (4), and *Passiflora* (165) with the greatest diversity in the Andean region (82%). The largest number of species is found between 1,000 and 2,000 m above sea level and the most common ones thrive in disturbed habitats, such as roadsides, cultivated land, and secondary forest (Ocampo et al. 2007). The distribution of the Passifloraceae has been drastically affected by deforestation, mainly in the Andean region. Its historical range corresponds to a region with a long history of livestock and agriculture that currently supports extensive plantations of coffee, sugar cane, rice, bananas, and potatoes. The country has 58 endemic Passifloraceae species, 95% of them exclusively Andean, implying a high extinction risk, as the Andes region is the most densely populated and disturbed of the country (Morales et al. 2007). The Department of Antioquia concentrates the highest diversity and endemism (5 spp.) of Colombian *Passiflora*, with 42% of the species, mainly in the Andean region (Ocampo et al. 2007). According to the categories and criteria of IUCN Red List of threatened species (IUCN 2003), Hernández and Garcia (2006) and Ocampo et al. (2007) have established that more than 110 Colombian species of Passifloraceae are threatened to some degree, with three species considered extinct.

The goal of the present study is to document the rediscovery of *Passiflora danielii* Killip, 1960 in the locality where it was originally described and in areas where it is likely to occur but not reported yet, and to assess its current status.

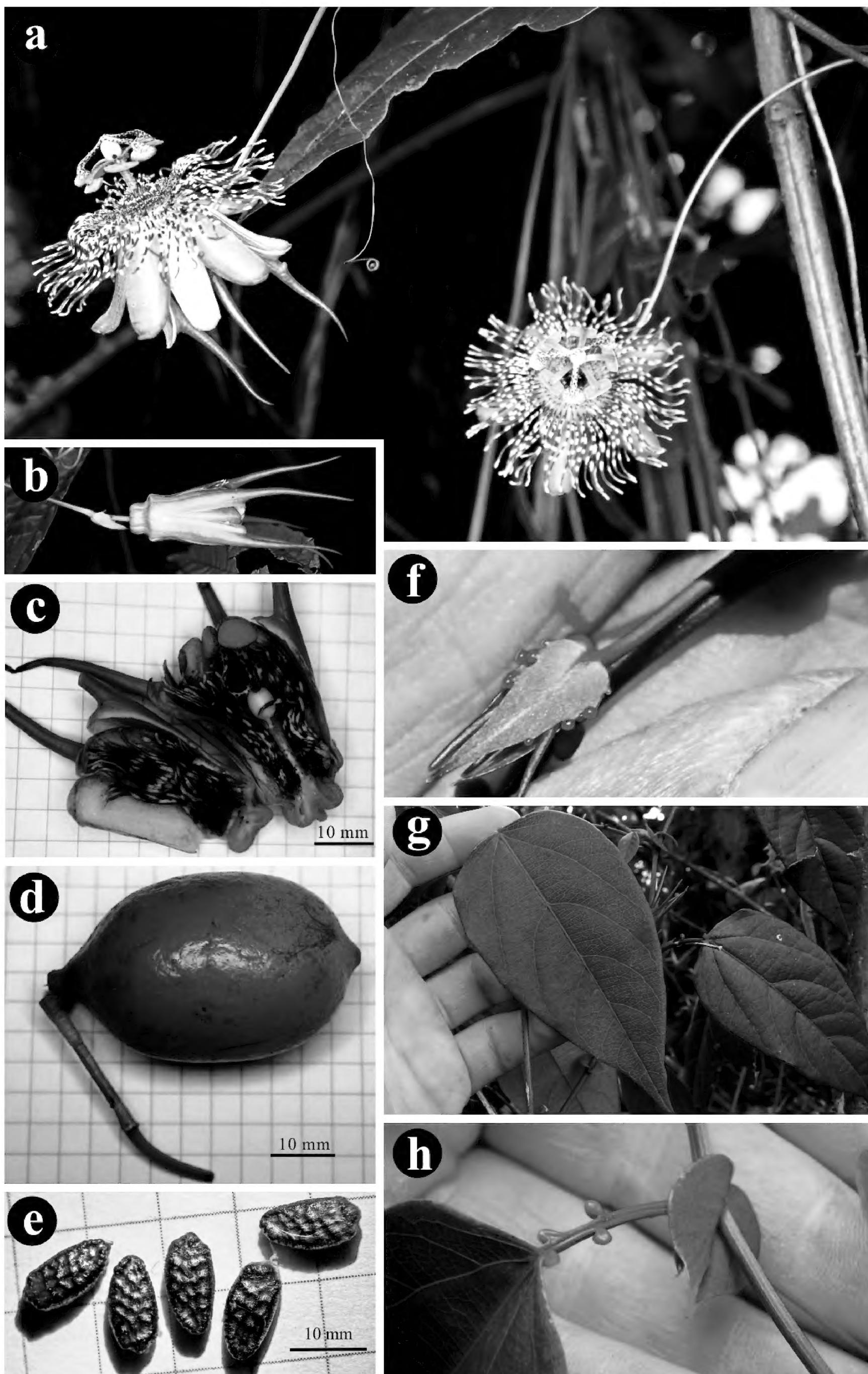
In August 1938, an enthusiast of Colombian flora, Brother Daniel F.S.C. (né Julián González Patiño), collected a plant of *Passiflora* in the Municipality of Cocorná, Department of Antioquia (Daniel 1968). The specimen was deposited in the U.S. National Herbarium (No. 1742750) and Killip (1960) described it as *P. danielii* in his *Supplemental Notes on the American Species of Passifloraceae with Descriptions of New Species*, belonging to the series *Simplicifoliae* of the subgenus *Passiflora*.

No other observation of the species has been reported since 1938. When we visited the recorded locality for *P. danielii* in the Municipality of Cocorná (Department of Antioquia), the forest had been cleared or heavily disturbed and the species was not found. However, we observed eight plants across four new localities in Cocorná. These newly collected specimens and photographs of fresh material of *P. danielii* allowed improving the original description of Killip (1960). The species is redescribed herein with data on morphology, ecology and geographic distribution.

We examined specimens from the major herbaria in Colombia: Fundación Universitaria de Popayán (AFP), Universidad del Cauca (CAUP), Jardín Botánico Eloy Valenzuela (CDMB), Universidad Tecnológica del Chocó

(CHOCO), Instituto de Ciencias Naturales, Universidad Nacional de Colombia (COL), Instituto Amazónico de Investigaciones Científicas (COAH), Universidad del Valle (CUVC), Universidad de Caldas (FAUC), Universidad de Antioquia (HUA), Universidad del Quindío (HUQ), Jardín Botánico de Medellín “Joaquín Antonio Uribe” (JAUM), Jardín Botánico de Bogotá (JBB), Universidad de los Llanos (LLANOS), Universidad Nacional de Colombia sede Medellín (MEDEL), Universidad de Nariño (PSO), Universidad Surcolombiana (SURCO), Universidad del Tolima (TOLI), Instituto para la Investigación y Preservación del Patrimonio cultural y Natural del Valle del Cauca (TULV), Universidad Nacional de Colombia sede Palmira (VALLE), Universidad Industrial de Santander (UIS) and other countries (Royal Botanic Gardens (K), Real Jardín Botánico de Madrid (MA), Missouri Botanical Garden (MO), New York Botanical Garden (NY), Museum National d’ Histoire Naturelle Paris (P), United States National Museum of Natural History (US). Only seven herbarium specimens were found labeled as *Passiflora danielii*, which were photographed (with color details) to describe the species: COLOMBIA. Antioquia, Cocorná, August 1938, *Brother Daniel* 1536 (isotype MEDEL, holotype US); Antioquia, Frontino, PNN Las Orquideas, 27 January 1979, *Alwyn H. Gentry, Enrique Rentería A. & Cruz Cecilia Estrada* 24643 (MO); Antioquia, Frontino, Nutibara, 1,900 m, 17 April 1987, *Dario Sánchez et al.* 1271 (MEDEL); Antioquia, San Luis, El Popal, 1,300–1,500 m, 11 November 1995, *Ramiro Fonseca* 5825 (HUA); Risaralda, Pereira, La Suiza-La Florida, 2,000 m, 25 September 2006, *Francisco Javier Roldán & Oscar Mosquera* 4037 (HUA); Risaralda, Pereira, La Suiza, 2,350 m, 27 January 1993, *William Vargas* 815 (FAUC). When we determined all specimens, we found that only Brother Daniel’s specimen (US and MEDEL) belongs to *Passiflora danielii*, while the last six are misclassified and correspond to *Passiflora oerstedii* Mast., subgenus *Passiflora* (Supersection *Stipulata*, Section *Granadillastrum*) according to the classification by Feuillet and MacDougal (2003).

Based on the high quality photographs of live material (Figure 1) and the additional herbarium specimens incorporated in the present study (isotype and holotype), a morphological description that more accurately reflects *Passiflora danielii* is presented here. Of particular interest are color details not perceptible in the older herbarium specimen. The observation of fresh material has provided additional insights into *P. danielii* regarding fruit characters, which were not described by Killip (1960). Due to the rarity of the species, photographs of *P. danielii* were taken and a single herbarium specimen was collected in March 2013 from Cocorná and deposited in the herbarium of the Universidad Nacional de Colombia sede Medellín (MEDEL; J. Restrepo, W. Giraldo and J. Ocampo, No. 210), as a voucher for morphological study.



**Figure 1.** Floral and vegetative characteristics of *Passiflora danielii*: a flowers at anthesis, b floral bud, c longitudinal transect of the flower, d immature fruit, e mature seeds, f ovate-lanceolate bracts with glandular margin, g ovate-lanceolate leaf, h petiolar nectaries and stipules. Photographs by Jorge Restrepo and Wilmer Giraldo.

Finally, we followed the infrageneric classification of Feuillet and MacDougal (2003) and to redescribe *Passiflora danielii* Killip (*supersection Stipulata, section Granadillastrum*): Type, COLOMBIA, Department of Antioquia, Municipality of Cocorná, August 1938, Brother Daniel 1536 (holotype: U.S. National Herbarium, No. 1742750; isotype: MEDEL, Herbario Gabriel Gutierrez, No. 29954). Description: Herbaceous vine; stem terete, slender, striate, glabrous; stipules semi-cordate, 6–10 mm long, 4–5 mm wide, green, abruptly cuspidate-acuminate (green-orange), attached laterally slightly above the rounded base, the costa strongly eccentric, glandular at margin (1–4 glands); petioles 32–54 mm long, glabrous, bearing slightly above the middle a pair of sessile, laterally compressed, concave glands about 1.5 mm. long and wide and another pair at the apex, the latter pair sometimes being borne instead at the margin of the blade close to the petiole; leaf-blades ovate-lanceolate, 80–178 mm long, 40–97 mm wide, acuminate, cordulate at the base, entire, 7-nerved, closely reticulate, concolorous, sublustrous and glabrous above, short-pilose on the nerves and veins beneath, the hairs divaricate, closely appressed to the surface of the blade, light or dark green; peduncles solitary, terete, 110–144 mm long (including pedicel of 14 mm), slender, glabrous; bracts ovate-lanceolate, 10–15 mm long, 5–8 mm wide, free to base, acute at apex, cordate at base, glandular at margin (4 glands), green, glabrous, deciduous; flowers of 40–60 mm in diameter, calyx tube broadly campanulate, about 6 mm long, 8–9 mm in diameter at throat, introrse at the base; sepals linear-lanceolate, 20–30 mm long, about 8 mm. wide at the base, horned dorsally just below the apex, the horn 12–29 mm long (green), whitish slightly violet inside, light-green outside; petals similar to the sepals about 27 mm long and 14 mm wide, obtuse, whitish to violet; corona filaments purple to violet, banded white at the base, in 5 series, the two outer filiform, 15–28 mm long, those of the succeeding series filiform, about 3 mm long, capitellate; operculum membranous, erect, about 5 mm long, filamentose to the middle; nectar ring a low ridge; limen tubular, 4 mm high, closely surrounding the base of the gynophore; ovary ovoid, glabrous, light green; styles, 9–11 mm. long, mottled with purple; fruit ovoid, 50–80 mm. long, about 35–45 mm. in diameter, weight 28.9–44.3 g, pulp 7.1–10.7 g, skin waxy, unripe when green and greenish yellow when ripe, unpleasant odor, flavor sweet and slightly acid, total soluble solids 12.5–12.8 (°Brix); seeds narrowly obovate, about 13 mm long and 6.5 mm wide, coarsely reticulate, dark brown, 78–161 seeds per fruit, surrounded by a white aril. Additionally, Granadilla de Cocorná is a vernacular name for this species.

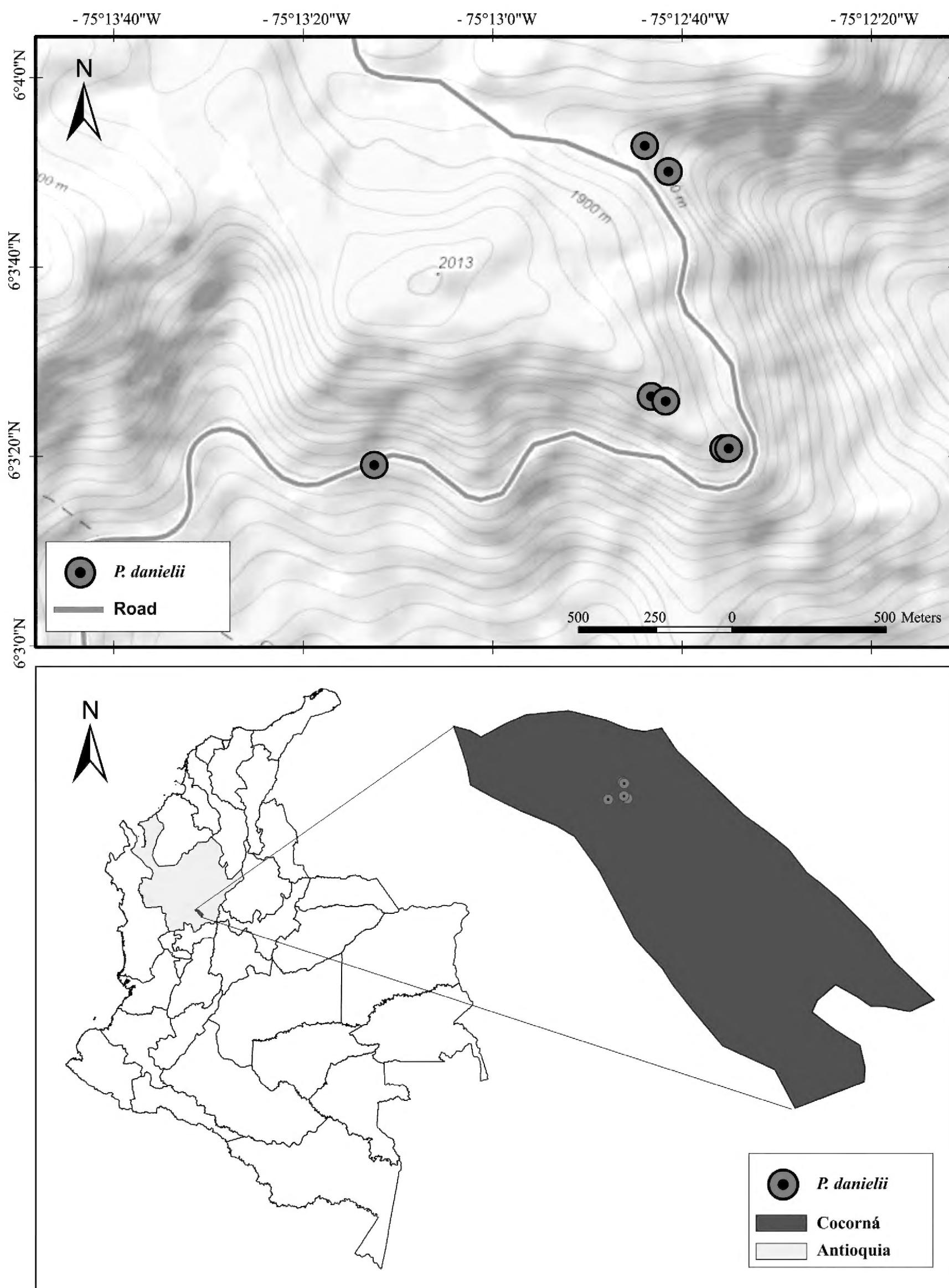
**PHENOLOGY:** flowering in August–September to February–March; fruiting from November–December to April–May.

**DISTRIBUTION:** rare narrow endemic to the Colombian, Department of Antioquia, Municipality of Cocorná, Eastern flank of the Central Cordillera (Figure 2).

**ECOLOGY:** *P. danielii* was observed on hillsides, along roadsides or along secondary forest margins, climbing onto shrubs or trees in thickets, at elevations ranging from 1,710 to 2,093 m above sea level. This species grows in areas with moist soil of texture sandy clay loam, annual mean temperature of 19.04°C and annual rainfall of 3,464 mm.

**CONSERVATION STATUS:** According to Myers et al. (2000) and Robbirt et al. (2006), rarity and endemism represent two factors of particular significance for decline and extinction. In this context, under the IUCN Red List guidelines (IUCN 2014) and supported with the Geospatial Conservation Assessment Tool – GeoCAT (Bachman et al. 2011), *Passiflora danielii* should be classified as critically endangered (CR), based on two assessment criteria, B2a and D. Within category B, *P. danielii* is classified as B2a, area of occupancy estimated less than 10 km<sup>2</sup>: severely fragmented and known to exist at a single location. With respect to criterion D, the population size is estimated to number fewer than 50 mature individuals, with just eight plants observed in Cocorná over one year of field survey. Our results are consistent with Ocampo et al. (2007), whose list classifies *P. danielii* in the critically endangered (CR) category, but not with the Red List of Passifloraceae published by Hernández and García (2006) where it is in the least concern (LC) category.

**Strategies of conservation:** Passifloraceae diversity is not well protected by the network of Colombian protected areas (Ocampo et al. 2010). The new localities where we found *Passiflora danielii* do not correspond with Andean protected areas and the *in situ* conservation of this threatened species, as well as its habitat, is urgent. Conservation or restoration efforts for *P. danielii* habitats must be integrated in the more general management at the landscape level. The latter can be ensured by coordinating existing actions for watershed protection, management of private and low-level public reserves, creation of environmental corridors, and improvement of agricultural practices that integrate the landscape. *Ex situ* conservation in botanical gardens and seedbanks is another strategy that must be implemented when critical habitats are destroyed. Another important aspect is the assessment of *P. danielii* as a germplasm resource for crop diversification programs, implying the need for a better understanding of the species' morphological and genetic diversity.



**Figure 2.** Distribution of *Passiflora danielii* at Cocorná, Department of Antioquia.

## ACKNOWLEDGEMENTS

We are grateful to David Costen, of the U.K. who first suggested to look for *Passiflora danielii*, and to Duván Gómez of Cocorná for suggesting possible places where we could find passion flowers. We also thank John Miles of the International Center for Tropical Agriculture (CIAT) for his comments and suggestions on the manuscript.

## LITERATURE CITED

Bachman, S., J. Moat, A. Hill, J. de la Torre and B. Scott. 2011. Supporting Red List threat assessments with GeoCAT: Geospatial Conservation Assessment Tool. *Zookeys* 150: 117–126. doi: 10.3897/zookeys.150.2109

Brooks, T.M., R.A. Mittermier, C.G. Mittermier, G.A.B. da Fonseca, A.B. Rylands, W.R. Konstant, P. Flick, J. Pilgrim, S. Oldfield, G. Magin and C. Hilton-Taylor. 2002. Habitat loss and extinction in the hotspots of biodiversity. *Conservation Biology* 16: 909–923.

doi: 10.1046/j.1523-1739.2002.00530.x

Daniel, H. 1968. Curiosidades de una flor y de una familia botánica (La Flor de la Pasión). Boletín del Instituto de la Salle, Bogotá. 208: 261–270.

Feuillet, C. and J.M. MacDougal. 2003. A new infrageneric classification of *Passiflora* L. (Passifloraceae). *Passiflora* 13(2): 34–38.

Gentry, A.H. 1986. Endemism in tropical versus temperate plant communities; pp. 153–181, in: M.E. Soulé (ed.). *Conservation biology: the science of scarcity and diversity*. Sunderland, Massachusetts: Sinauer Associates.

Hernández, A. and N. García. 2006. Las pasifloras (familia Passifloraceae); pp. 553–663, in: García N., and G. Galeano (eds.). *Libro rojo de plantas de Colombia. Las bromelias, las labiadas y las pasifloras*. Vol. 3.

IUCN World Institute for Conservation and Environment. 2003. Guidelines for application of IUCN Red List criteria at regional levels. Version 3.0. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. 25 pp. [http://intranet.iucn.org/webfiles/doc/SSC/SSCwebsite/Red\\_List/regionalguidelinesEn.pdf](http://intranet.iucn.org/webfiles/doc/SSC/SSCwebsite/Red_List/regionalguidelinesEn.pdf)

IUCN Standards and Petitions Subcommittee. 2014. Guidelines for Using the IUCN Red List Categories and Criteria. Version 11. Prepared by the Standards and Petitions Subcommittee. 87 pp. <http://www.artsdatabanken.no/File/1836/Guidlines%20versjon%202011>

Killip, E.P. 1938. The American Species of Passifloraceae. *Botanical Series, Field Museum of Natural History*. Chicago IL, USA. Volume 19 (Part 1, 2): 1–613. doi: 10.5962/bhl.title.2269

Killip, E.P. 1960. Supplemental notes on the American species of Passifloraceae with descriptions of new species. *Bulletin Bulletin of the United States National Museum. Smithsonian Institution*. Washington, DC, USA. Volume 35 (Part 1): 19–20.

Kreft, H and W. Jetz. 2007. Global patterns and determinants of vascular plant diversity. *PNAS* 104(14): 5925–5930. doi: 10.1073/pnas.0608361104

Krosnick, S.E., A.J. Ford and J.V. Freudenstein. 2009. Taxonomic revision of *Passiflora* subgenus *Tetrapathea* including the monotypic genera *Hollrungia* and *Tetrapathea* (Passifloraceae), and a new species of *Passiflora*. *Systematic Botany* 34: 375–385. doi: 10.1600/036364409788606343

Morales, M., J. Otero, T. Van der Hammen, A. Torres, C. Cadena, C. Pedraza, N. Rodríguez, C. Franco, J.C., Betancourth, E. Olaya, E. Posada and L. Cárdenas. 2007. *Atlas de páramos de Colombia*. Bogotá, D.C.: Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. 208 pp.

Myers, N., R.A. Mittermeier, C.G., Mittermeier, G.A.B. da Fonseca and J. Kent. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858. doi: 10.1038/35002501

Ocampo, J., G. Coppens d'Eeckenbrugge, M. Restrepo, A. Jarvis, M. Salazar and C. Caetano. 2007. Diversity of Colombian Passifloraceae: biogeography and an updated list for conservation. *Biota Colombiana* 8(1): 1–45.

Ocampo, J., G. Coppens d'Eeckenbrugge and A. Jarvis. 2010. Distribution of the genus *Passiflora* L. diversity in Colombia and its potential as an indicator for biodiversity management in the Coffee Growing Zone. *Diversity* 2(11): 1158–1180. doi: 10.3390/d2111158

Robbirt, K.M., D.L. Roberts and J.A. Hawkins. 2006. Comparing IUCN and probabilistic assessments of threat: Do IUCN red list criteria conflate rarity and threat? *Biodiversity and Conservation* 15: 1903–1912. doi: 10.1007/s10531-005-4307-2

Ulmer, T. and J.M. MacDougal. 2004. *Passiflora: passionflowers of the world*. Timber Press Portland, Oregon. 430 pp.

Yockteng, R., G. Coppens d'Eeckenbrugge and T. Souza-Chies. 2011. *Passiflora*; pp. 129–171, in: Chittaranjan, K. (ed.). *Wild Crop Relatives: Genomic and Breeding Resources. Tropical and Subtropical Fruits*. Springer Verlag, Berlin, Heidelberg.

**Authors' contribution statement:** JJR, WG and JO collected the data, JO determined the living and herbarium specimens, JO and JJR conducted the research and wrote the text, JO made the distribution map, JJR and WG photographed the living specimens.

**Received:** July 2014

**Accepted:** February 2015

**Editorial responsibility:** Angelo Manzatto